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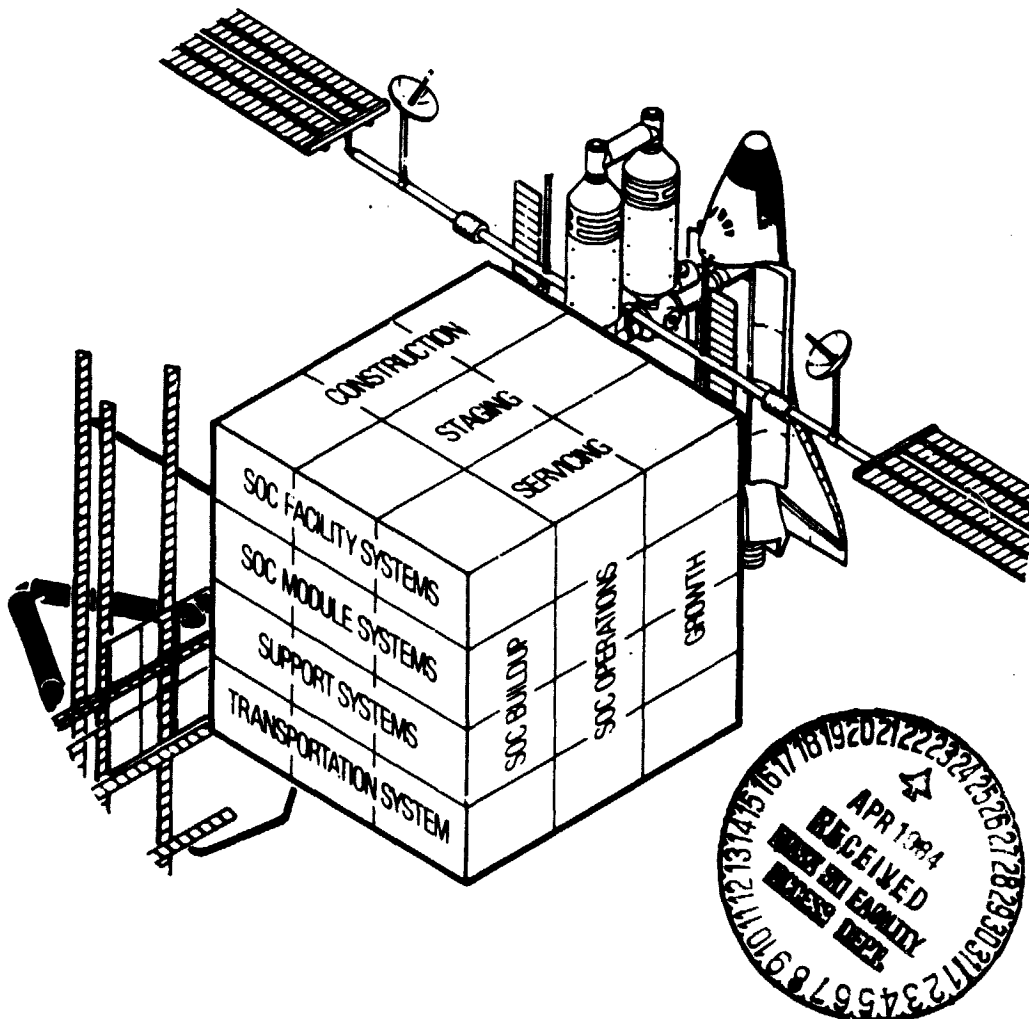
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SPACE OPERATIONS CENTER — SHUTTLE INTERACTION STUDY EXTENSION (NAS9-16153)

MONTHLY PROGRESS REPORT NO. 3

OCTOBER 1981



SOC/SHUTTLE INTERACTION STUDY EXTENSION

THIRD MONTHLY PROGRESS REPORT

October 6, 1981 to November 6, 1981

SECTION I. SUMMARY

A. Progress

Shuttle Fleet Utilization and Programmatics

Fleet utilization analyses have been initiated. Traffic analyses are being conducted based on a mission model obtained with Rockwell discretionary resources. Representative manifests are being developed for all mission categories. STS flight rates through the year 2000 will be generated using standard orbiter performance characteristics. The main emphasis of the fleet utilization analysis is on SOC versus no SOC trades and factors bearing on the use and benefits of a dedicated orbiter for SOC delivery missions.

SOC Assembly Operations

Additional simulations have been performed with the Remote Manipulator System Kinematics Analysis Tool (RMSKAT) program. These simulations identified the final location of the RMS device on each module. These positions will permit the RMS joint rotation angles to be within the constraints of the RMS capability.

Shuttle System Propellant Scavenging

Rockwell discretionary efforts establishing the practical feasibility of suborbital propellant scavenging have been completed. The results were presented at the mid-term review. Additional presentations were made to MSFC (28 October), NASA Headquarters (29 October) and KSC (30 October). Contract efforts are underway to define SOC interfaces for the delivery of these propellants to a SOC storage facility. Fleet utilization analyses (Task 1.0) will determine the main benefits of propellant scavenging to the SOC logistics traffic.

Flight Support Facility

Dollar costs are being generated for each of the six servicing scenarios as reported in the mid-term briefing. These costs included the cost of the unique equipment identified for each scenario and also the costs of the man hours required to perform the servicing operations. The ground servicing functions and man hours have been revised to more closely match the Shuttle Turnaround Analysis Report (STAR 20).

B. Planning

Figure 1, the task planning schedule, indicates the current activities status including the company funded Shuttle E.T. propellant recovery implications task. The milestones concerning the final report dates and the final briefing have been revised. The final report dates reflect the previously agreed to arrangement. The final briefing date is that anticipated per previous discussions.

C. Action Status

No outstanding actions.

D. Problem Status

No significant problems.

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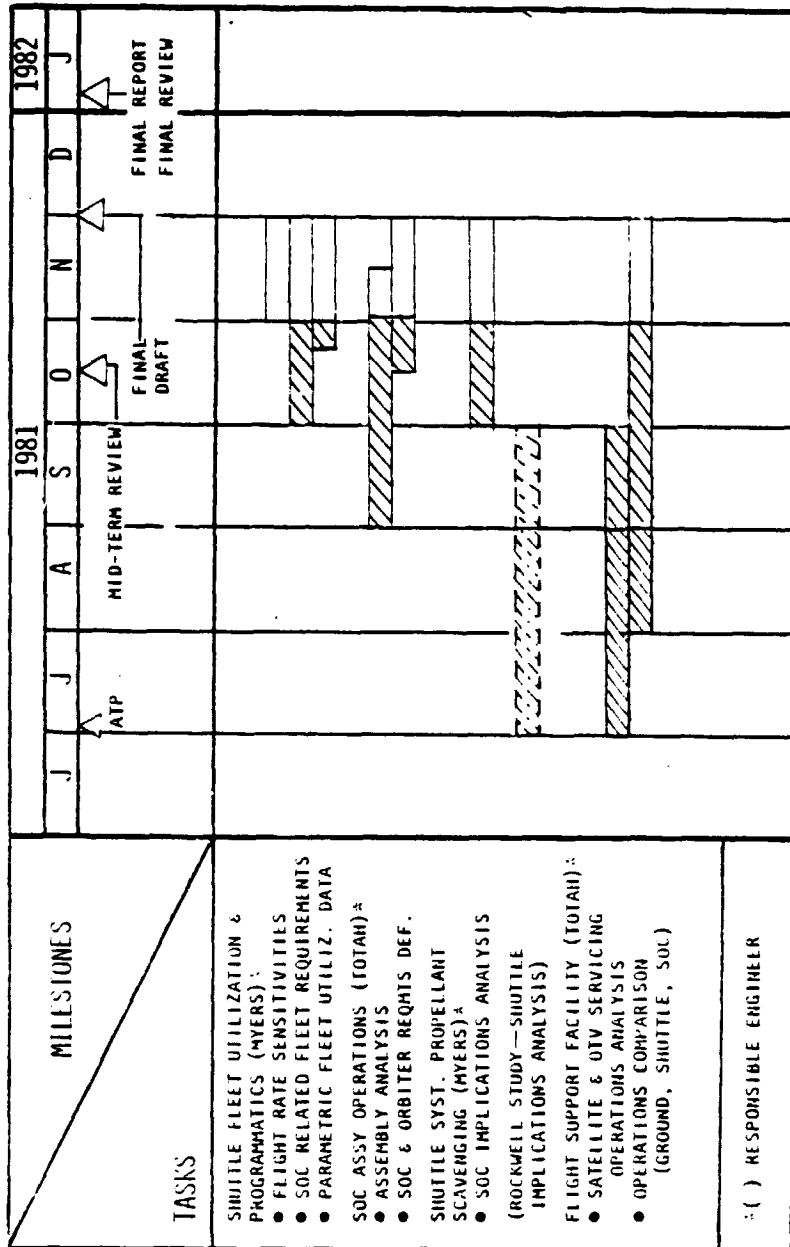


Figure 1. Planned Activity

SECTION II. TASK PROGRESS

Shuttle Fleet Utilization and Programmatics

Task 1.0 efforts have been initiated. The current focus is on traffic analyses based on a mission model derived with Rockwell discretionary resources. Each major sector of the mission model (commercial communications, NASA R&D, DOD, etc.) is being analyzed to synthesize representative spacecraft and/or STS manifest elements for later conversion into STS flight rates. The total mission model will be screened to catalog missions into candidate SOC related and non-SOC missions.

This representative manifest data will be utilized to determine the amount of unused cargo bay space and payload weight capability that could exist on each SOC delivery flight. Further analyses will then determine how much propellant could be delivered to the SOC on these missions using payload top-off and propellant scavenging techniques. Payload top-off involves bringing the orbiter up to its maximum payload capability by adding propellants in the unused space weights of the various flight manifests. Propellant scavenging refers to the concept of recovering unused propellants from the ET and the main propulsion system before ET jettison. Up to 9500 lbs or more can be recovered on maximum payload launches. The total propellants per year delivered to the SOC in this way can be compared to the OTV propellant requirements to determine how many tanker flights are required to support the mission model previously defined.

The representative manifest data will be further used to derive standard equipment sets suitable for use with an orbiter dedicated to SOC resupply mission.

SOC Assembly Operations

The final simulations have been performed, via the RMSKAT computer program, and have determined the appropriate locations of the RMS grapple device on each of the modules. The locations determined will permit the RMS to perform the SOC assembly operations without exceeding the joint rotation constraints of the RMS. Figure 2 lists the joint rotation angles of each assembly operation. In addition to being within the joint rotation capability, the selection of the grapple positions also attempted to stay within the desired joint angles as suggested by SPAR. Two areas were noted where the rotation angles slightly exceeded these desired; but not mandatory; angles, and are noted in Figure 2. We believe that the grapple positions determined are acceptable for the controlled assembly of the SOC modules by the RMS from the orbiter.

All of the grapple positions are on the main body of each module except in the case of the tunnel module. This module, however, requires that the grapple be located away from the module as illustrated in Figure 3. This location, therefore, requires the addition of an external bracket to support the grapple device.

Shuttle System Propellant Scavenging

Current task efforts are centered on the definition of propellant transfer concepts for delivering the propellants to a SOC storage facility. Basic equipment needed on the SOC will be identified along with a representative propellant "losses" model. The propellant loss model will aid in better understanding total OTV propellant logistics requirements and in identifying areas where technology advancements would be beneficial. SOC propellant facility characteristics spanning the range of ET propellant scavenging scenarios will

MODULE	SY (-177.4 TO 177.4)	SP (0.6 TO 142.4)	EP (-0.4 TO -157.6)	WP (-116.4 TO 116.4)	WY (-116.6 TO 116.6)	WR (-442 TO 442)
SM-1 STOWED	-31.51	49.50	-69.39	-46.78	-32.85	-51.53
SM-1 DEPLOYED	-119.14	129.60	-109.92	-42.22	27.33	100.53
SM-2 STOWED	-31.51	49.15	-69.39	-46.78	-37.86	-51.53
SM-2 DEPLOYED	-8.73	85.31	-110.91	-41.17	-68.72	114.74
HM-1 STOWED	-34.96	68.48	-92.42	-40.76	-31.44	132.19
HM-1 DEPLOYED	-21.49	78.27	-42.47	-79.79	-61.31	139.73
HM-2 STOWED	-34.96	68.48	-92.42	-40.76	-31.44	132.19
HM-2 DEPLOYED	-21.49	78.27	-42.47	-79.79	-61.31	139.73
LM STOWED	-28.56	52.43	-68.42	-52.49	-33.98	125.21
LM DEPLOYED	-61.31	75.58	-68.93	-28.61	-26.91	169.66
TM STOWED	-37.52	77.45	-145.47	-17.29	27.18	-57.0
TM DEPLOYED	56.73	94.02	-54.29	112.14	46.31	130.

Figure 2. RMS Joint Angles—SOC Assembly

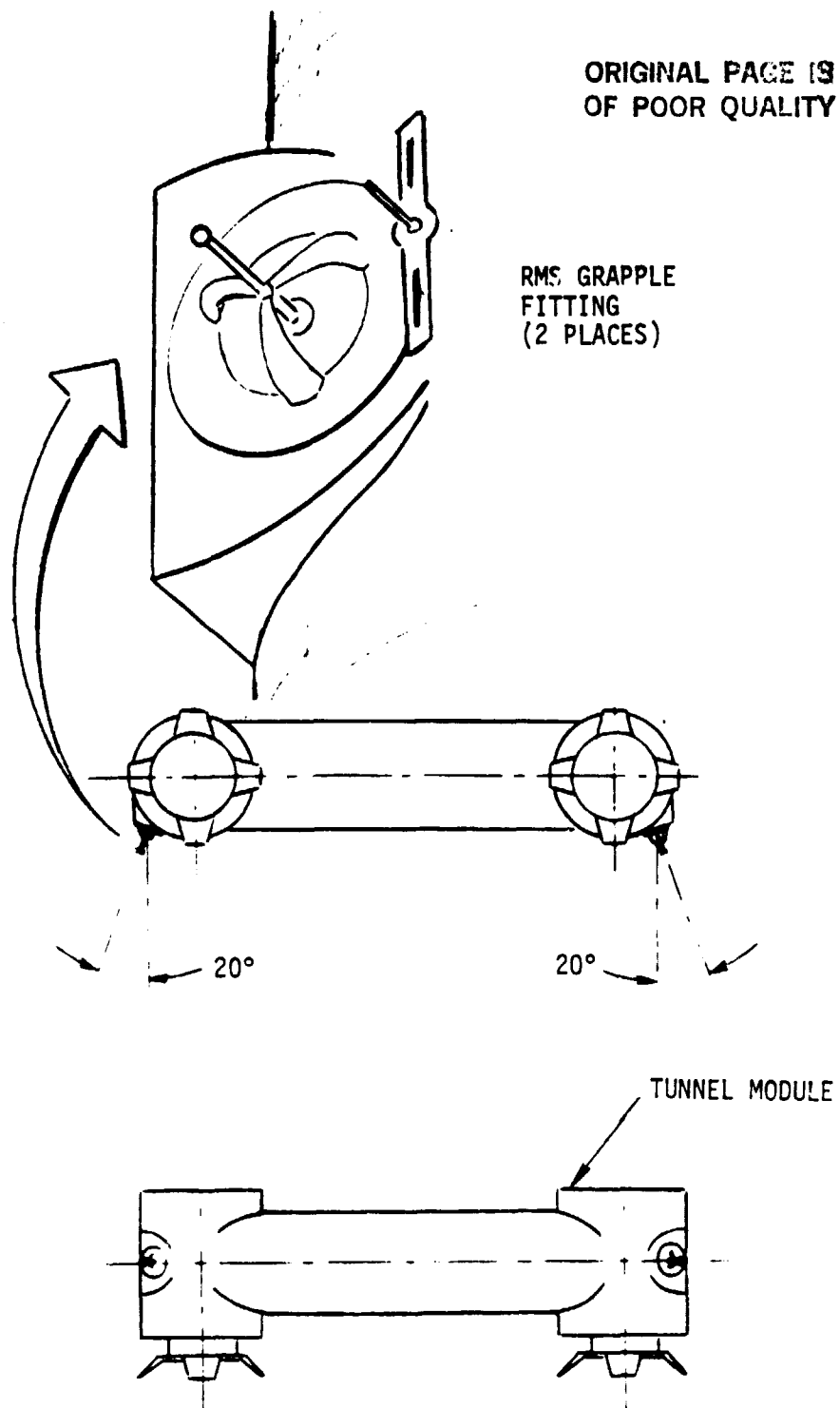


Figure 3. Tunnel Module Grapple Location

be considered. This includes propellant amounts ranging from the 9500 lbs associated with maximum payload launches to the 70,000 lb plus value associated with the "dry launch" concept for a tanker flight (orbiter is launched with an empty tank as its only payload which results in approximately 70,000 lbs of unused propellants).

Flight Support Facility

The principal effort being accomplished on this task is to obtain cost dollars to compare the various servicing activities as previously determined and reported on at the mid-term briefing. The man hours required to perform the servicing functions have been reviewed and revisions made as required to have comparable operations activities. Information and comments received from the KSC personnel during our briefing there on October 30, 1981 have influenced the ground operations revisions. Figure 4 shows the OTV ground servicing operations superimposed on the STAR 20 timeline for payload installations at the launch pad. This timeline and activities was used as the ground operations reference document.

Data sheets have been developed for each piece of unique equipment identified that is required to perform servicing for each servicing scenario. These data sheets when completed provide the cost associated with each piece of equipment. Figures 5 and 6 is an example of a completed data sheet and a description of the piece of equipment being costed.

STAR 0200

LEVEL II TIMELINE ALLOCATION PAYLOAD INSTALLATION AT LAUNCH PAD

FIGURE 2

BASILINE

SIC 111 OPERATIONS PLANNING OFFICE
R.H. Buckley
ROBERT H. BUCKLEY
SP OPS

28 MAY 1981

LAUNCH AREA 1.0 HRS

ORBITER PROCESSING FACILITY RD 5 HRS

VEHICLE ASSEMBLY BLOS 3.0 HRS

LAUNCH PAD 32.5 HRS

LAUNCH ST 160.0 HRS

LEGEND

OTV SERVICE
1. XX LEVEL III CONTROLLED FUNCTION.
2. [XX] LEVEL III REFERENCED FUNCTION.
3. ← CHANGED SINCE LAST STAR.

Figure 4. OTV Servicing Timeline

COST ANALYSIS SHEET																																							
ITEM OR FUNCTION EXTENDABLE NON-PROPULSIVE BOOM	PAGE	1 OF 2																																					
	REF. NO.																																						
PROJECT/SYSTEM OTV-SOC SERVICING	WBS NO.																																						
ACTIVITY PURGING & VENTING OTV	NO.	7.0																																					
<p>DESCRIPTION/SPECIFICATION/DESIGN</p> <p>Boom required to avoid contaminants from purge gases.</p> <p>See attachment.</p>																																							
<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 40%;"></th> <th style="width: 10%; text-align: center;">DDT&E</th> <th style="width: 10%; text-align: center;">\$ = \bar{M}</th> <th style="width: 10%; text-align: center;">TU</th> <th style="width: 30%;"></th> </tr> </thead> <tbody> <tr> <td>TOTAL MASS (KG)</td> <td></td> <td style="text-align: center;"><u>41</u></td> <td></td> <td></td> </tr> <tr> <td>STRUCTURAL MASS (KG)</td> <td style="text-align: center;">0.263</td> <td style="text-align: center;"><u>20</u></td> <td></td> <td style="text-align: center;">0.143</td> </tr> <tr> <td>MECHANISMS MASS (KG)</td> <td style="text-align: center;">0.655</td> <td style="text-align: center;"><u>20</u></td> <td></td> <td style="text-align: center;">0.399</td> </tr> <tr> <td>ELECTRICAL/PD MASS (KG)</td> <td></td> <td style="text-align: center;"><u> </u></td> <td></td> <td></td> </tr> <tr> <td>ELECTRONIC MASS (KG)</td> <td style="text-align: center;">0.019</td> <td style="text-align: center;"><u>1</u></td> <td></td> <td style="text-align: center;">0.20</td> </tr> <tr> <td>REQUIRED QUANTITY</td> <td></td> <td style="text-align: center;"><u>1</u></td> <td></td> <td></td> </tr> </tbody> </table>						DDT&E	\$ = \bar{M}	TU		TOTAL MASS (KG)		<u>41</u>			STRUCTURAL MASS (KG)	0.263	<u>20</u>		0.143	MECHANISMS MASS (KG)	0.655	<u>20</u>		0.399	ELECTRICAL/PD MASS (KG)		<u> </u>			ELECTRONIC MASS (KG)	0.019	<u>1</u>		0.20	REQUIRED QUANTITY		<u>1</u>		
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Figure 5.

SERVICING ACTIVITY DATA

FUNCTION ITEM	6.0 SAFE & CHECKOUT OTV	ATTACHMENT	
METHOD		PAGE	2 of 2
SUBJECT	SOC REQUIREMENTS		

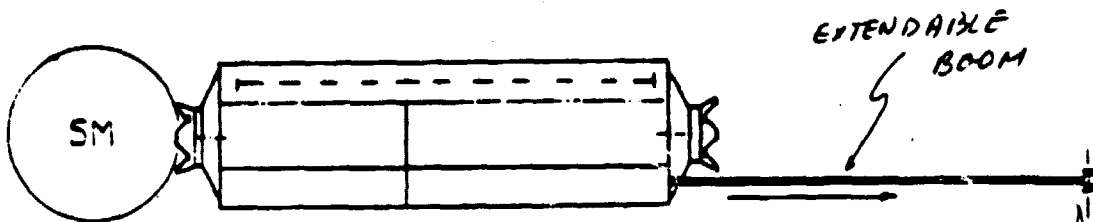


FIG 1

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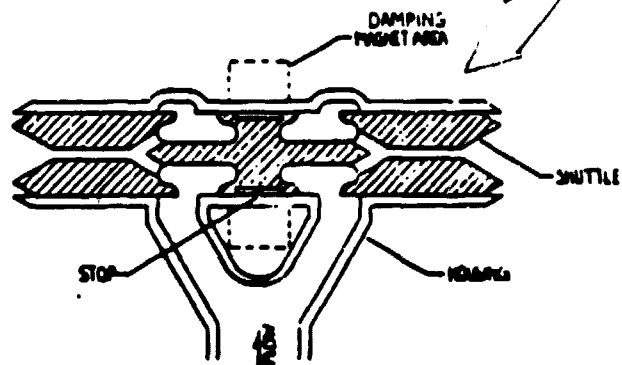


FIG 2

An expulsion system for purge and vent of OTV expendables tanks.

Figure 1 - An expulsion arm, extendible from the service fixture to transmit overboard gases away from the SOC to minimize or prevent contamination.

Figure 2 - A non-reactive jet to minimize or prevent reaction forces against the SOC assembly.

Outboard ends of free-floating shuttle absorb all reaction forces such that the input orifices meter the flow of gasses to center the shuttle at a location resulting in a balanced reaction.

Figure 6.

SECTION III. PLANS

The principle effort remaining is that of documenting the results of the four tasks. Additional data will continue to be developed as required to complete the contract effort as scheduled.

SECTION IV. EXPENDITURES

Planned and actual direct labor hours are shown in Figure 7.

SCHEDULE

1	SHUTTLE FLEET UTILIZATION & PROGRAM
2	SOC ASSEMBLY OPERATIONS
3	SHUTTLE SYST PROPELLANT SCAVENGING
4	FLIGHT SUPPORT FACILITY

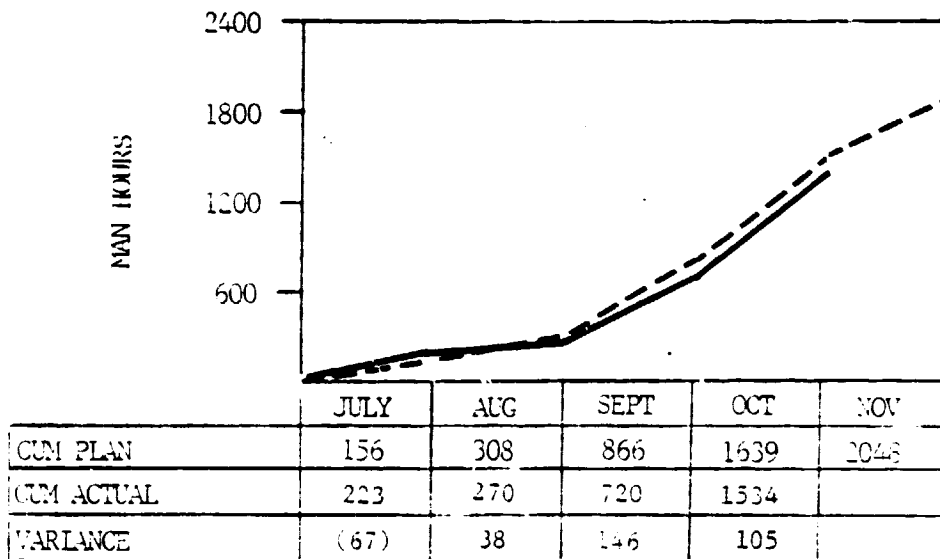


Figure 7. Space Operations Center Shuttle Interaction
Part II, NAS9-16153, G.O. 42690